

**TITLE: LONG WAVELENGTH SCINTILLATORS FOR FIBER-OPTIC APPLICATIONS**

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Long Wavelength Scintillators For Fiber-Optic Applications, P. LYONS, L. FRANKS, S. LUTZ, J. FLOURNOY, E. FULLMAN,\* Los Alamos Scientific Laboratory, EG&G/Santa Barbara, EG&G/Kirtland-The use of fiber optics in plasma diagnostics has spurred the development of long wavelength scintillators with fast temporal characteristics. In this paper we describe several new liquid scintillator systems with fluorescent emissions maxima up to 730 nm. Subnanosecond scintillator FWHM response times have been obtained by the operation of liquid scintillators at elevated temperatures. Data on fiber system sensitivity versus fiber length and scintillator emission wavelength will be presented.

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## LONG WAVELENGTH SCINTILLATORS FOR FIBER-OPTIC APPLICATIONS

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### INTRODUCTION

The absorption spectrum of optical fibers exceeds 45 dB/km near 400 nm and decreases to about 10 dB/km at 600 nm. This fact, coupled with the potential of fiber optics as a high-bandwidth, low-loss, inexpensive transmission medium for use in plasma diagnostics, has fostered interest in red scintillators. For our applications,<sup>1</sup> an optimum scintillator should have a peak emission wavelength  $> 600$  nm, a FWHM response time  $< 2$  ns, and a linear response at dose rates greater than  $10^{12}$  rad/s. In this paper we shall discuss three different scintillator systems, all with potential for use in fiber-optic plasma diagnostic experiments. Early work in this program was summarized in Ref. 2.

### EXPERIMENTAL TECHNIQUE

Our basic approach in the development of long wavelength scintillators has been to effect, through suitable intermediate solutes, the transfer of excitation energy from the 300-400 nm region of conventional scintillator solutions to the 500-600 nm absorption bands of selected red dyes.

All solvents and solutes used in this study were obtained from commercial suppliers without further purification. A commercial plastic fluor, NE108, was used throughout as an intensity standard.

The basic time response and relative efficiency measurements were made using an electron linear accelerator and its associated data acquisition system. The fluor samples were irradiated with a 50-ps burst of 6-MeV electrons. Optical notch filters were employed to determine the spectral content of the electron excited fluorescence. Time-integrated emission and excitation spectra of all solutions were also measured with a Perkin-Elmer Fluorescence Spectrophotometer, Model MPF44A.

## RESULTS

TPB Systems--A solution of 8 gm/l 2-phenyl-5-(4-biphenyl) 1,3,4 diazole (PBD) and 8 gm/l 1,1,4,4 tetraphenylbutadiene (TPB) dissolved in psuedo-cumene has been successfully used in Nevada Test Site fiber-optic experiments.<sup>3</sup> The emission maxima ( $\lambda_p$ ) of this solution is approximately 480 nm. Although this is far to the blue of our 600 nm requirements, the TPB emission band is very broad, extending to beyond 600 nm. When this fluor's emission spectra is folded with the absorption spectrum of 500 meters of graded-index fiber, the emission peak is shifted to 540 nm. When butyl-PBD, a highly soluble derivative of PBD, is used as the primary solute, it is possible to create a blue-green emitting scintillator with a 830-ps FWHM response time.<sup>2</sup>

Coumarin Systems--Coumarin 540A, a commonly used laser dye, has been studied in a binary solution with benzyl alcohol. The FWHM decreases with increasing Coumarin concentration from 12.3 ns at 0.1% to 1.3 ns at 10% (near saturation). At high concentrations the emission maximum is at 570 nm. The high solubility of the Coumarin 540A in benzyl alcohol apparently indicates the effects of the low G value for production of the first excited singlet state.

Temperature Effects--The efficiency and response time of a ternary system, Nile Blue Nitrate, and 2,5 Diphenyl-1,3,4 oxadiazole (PPD), dissolved in benzyl alcohol, has been studied as a function of temperature. At room temperature, this fluor has a FWHM response time of 5.5 ns,  $\lambda_p$  = 730 nm. As the temperature is increased, the FWHM decreases. At 160°C, FWHM = 1.9 ns. Further, the quenching affect of phenol is enhanced at elevated temperatures. In the case of combined thermal and phenol quenching, the FWHM at 160°C is ~ 700 ps with a peak efficiency comparable to that found without phenol.

## SUMMARY

Efficiency comparisons, as well as detailed data on composition and temperature variations, will be presented in the final paper. Only the TPB system has been used in plasma diagnostics to date.

## REFERENCES

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